
Cundall Manchester © Thierry Cardineau Photography

Healthy Building Design - Air Quality Considerations

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Cundall is a consultancy practice in the built environment…

- Acoustics
- Air quality and odour
- Audio Visual (AV)
- Building automation
- Building Performance Services (BPS)
- Building services engineering
- Civil engineering
- Construction design and management consultancy
- Digital engineering
- Fire engineering
- Geotechnical and geoenvironmental
- Health, wellbeing and productivity
- Information technology
- Lighting design
- Planning
- Security
- Smart buildings
- Structural engineering
- Sustainability
- Transportation
- Vertical transportation

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Air Quality – Design Considerations and Solutions

Criteria for design

- Target pollutants concentrations
- Air Quality Neutral / Positive
- Ventilation rates

Pollutant concentrations

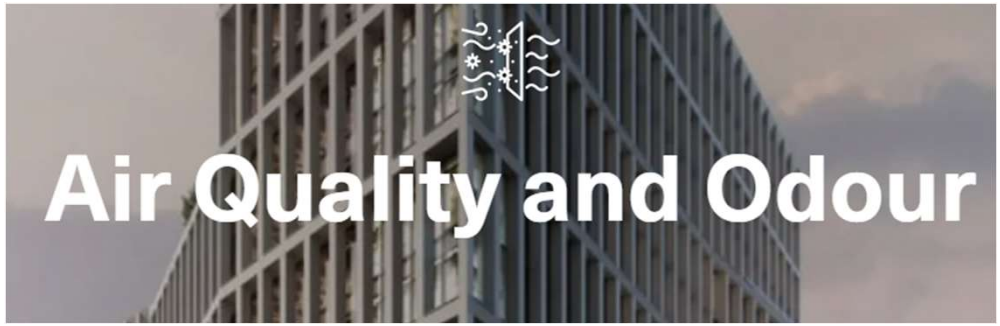
- Ventilation strategy - Informed by advanced dispersion modelling and/or monitoring

Early design input

- Urban design
- Building geometry & density
- Green infrastructure

Final Approach

- Materials selection
- Filtration selection
- pre-occupancy and operational indoor air quality testing
- Further guidance



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Criteria for design
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Criteria for Design

Target levels

- National Air Quality Objectives (legal targets)
- World Health Organisation - guidance on acceptable levels
- Part F
- Other voluntary schemes – e.g. BREEAM, the WELL Building Standard
- AirRated offer indoor air quality benchmarks
- RESET
- WHO levels are lower than HSE levels for occupational health
- ASHRAE – atmospheric corrosivity

BESA publication HW002: Guide to good practice: Indoor air quality for health and well-being - includes a table of recommended levels of common contaminants that is a useful benchmark for IAQ

BESA guidance:
https://www.thebesa.com/indoor-air-quality/?platform=hootsuite

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Building Regulations Part F – Ventilation –

Table B1 Indoor air pollutants guidance values[1][2]

Pollutant	Exposure limit	Exposure time
Carbon monoxide (CO)	100mg/m³	15-minute average
	30mg/m³	1-hour average
	10mg/m³	8-hour average
Nitrogen dioxide (NO_2)	200µg/m³	1-hour average
	40µg/m³	1-year average
Formaldehyde (CH_2O)	100µg/m³	30-minute average
	10µg/m³	1-year average
TVOC[3]	300µg/m³	8-hour average

NOTES:

1. No safe levels can be recommended for benzene or trichloroethylene so they have not been considered in the definition of ventilation rates in dwellings. The best strategy for reducing their concentration indoors may be to control them at source.
2. Even if the designer and builder choose to reduce volatile organic compound (VOC) levels in dwellings by controlling them at source, the ventilation requirements must still be met.
3. The total volatile organic compound (TVOC) metric is representative of all airborne indoor air VOC concentrations and should not be used as a direct indicator of health. The simplified metric is used as an indicator for the purpose of ventilation control strategies. As an alternative to the TVOC limit, individual VOC limits may be used where justified in accordance with the guidance in paragraph B5.

HM Government

The Building Regulations 2010

Ventilation

F

APPROVED DOCUMENT

Volume 1: Dwellings

Requirement F1: Means of ventilation

Regulations: 39, 42 and 44

HM Government

The Building Regulations 2010

Overheating

O

APPROVED DOCUMENT

Requirement O1: Overheating mitigation

Regulations: 40B

2021 edition – for use in England

2021 edition – for use in England

Ventilation rates – listed in Part F of Building Regs

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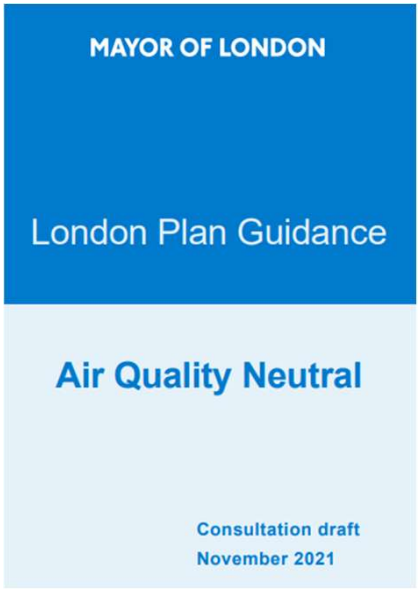
Design for Air Quality Neutral, Air Quality Positive

Air Quality Neutral is a term for developments that **do not contribute to air pollution beyond allowable benchmarks**. Considers **building** and **transport** emissions associated with the Proposed development



"*The **Air Quality Positive** approach aims to maximise benefits to local air quality in and around a large-scale development sites and masterplan area while also minimising exposure to existing sources of poor air quality. It requires planners, designers, architects and air quality experts to demonstrate what measures have been taken during the design stages to achieve the best possible outcomes for air quality*". Mayor of London
https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/london-plan-guidance/air-quality-positive-aqp-guidance

Achieving AQ Neutral directly links to sustainability goals.

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CIBSE, BRE & IAQM Indoor Air Quality Guidance

Health and wellbeing in building services

CIBSE

Monitoring indoor environmental quality

CIBSE

TM68: 2022


bre

IP 9/14

Information Paper

Locating ventilation inlets to reduce ingress of external pollutants into buildings

A new methodology

Hong Cheng, Vina Kukadia* and David Hall

Effective ventilation of buildings to provide optimum indoor air quality relies on good outdoor air quality in the locality of the building. However, in practice, outdoor air is often contaminated by pollutants from external sources. A new methodology giving a Pollutant Ingress Index has been developed to identify the areas of a building where pollutant ingress is most likely to occur and to determine the relative magnitude of this ingress. Application of the methodology will assist with:

- optimum placement of building ventilation inlets so that pollution from local sources can be minimised, thereby providing improved indoor air quality
- carrying out more effective air quality assessments in relation to indoor air quality, thereby ensuring successful planning applications for new developments and refurbishment projects
- developing strategies to protect building occupants from external toxic contaminant releases, whether accidentally (eg from storage tanks and fires) or intentionally (eg from chemical, biological, radiological and explosive incidents).

The methodology is intended for use by building industry professionals (eg architects, developers, planners and building services engineers) and regulatory authorities (eg environmental health, building control and planning officers and public health departments).

* For enquiries concerning this work, please contact Dr V Kukadia, BRE, Bucknalls Lane, Watford WD25 9XX; Tel: +44 (0) 1923 664878; Email: kukadiav@bre.co.uk.

Figure 1: Air pollution in cities can be a problem

Introduction

Studies have shown that the general population typically spends 90% or more of their time indoors and that the most susceptible individuals, such as the elderly and those with pre-existing medical conditions, spend almost all of their time indoors (Hancock, 2002; Jenkins et al, 1992). Therefore, the quality of the indoor air is of great importance to their health, comfort and well-being.

Effective ventilation of buildings to provide optimum indoor air quality relies on good outdoor air quality in the locality of the building. However, in practice, outdoor air is often contaminated by pollutants from external sources. For example, in the UK, there are many areas, in particular in major cities such as London, where UK air quality standards for nitrogen dioxide and fine particles (PM_{10}) are regularly breached (GLA, 2010). As a result, indoor air is likely to experience higher concentrations of common air pollutants from outdoor sources, especially if buildings have not been designed effectively to reduce their ingress (Kukadia and Palmer, 1998).

IHS

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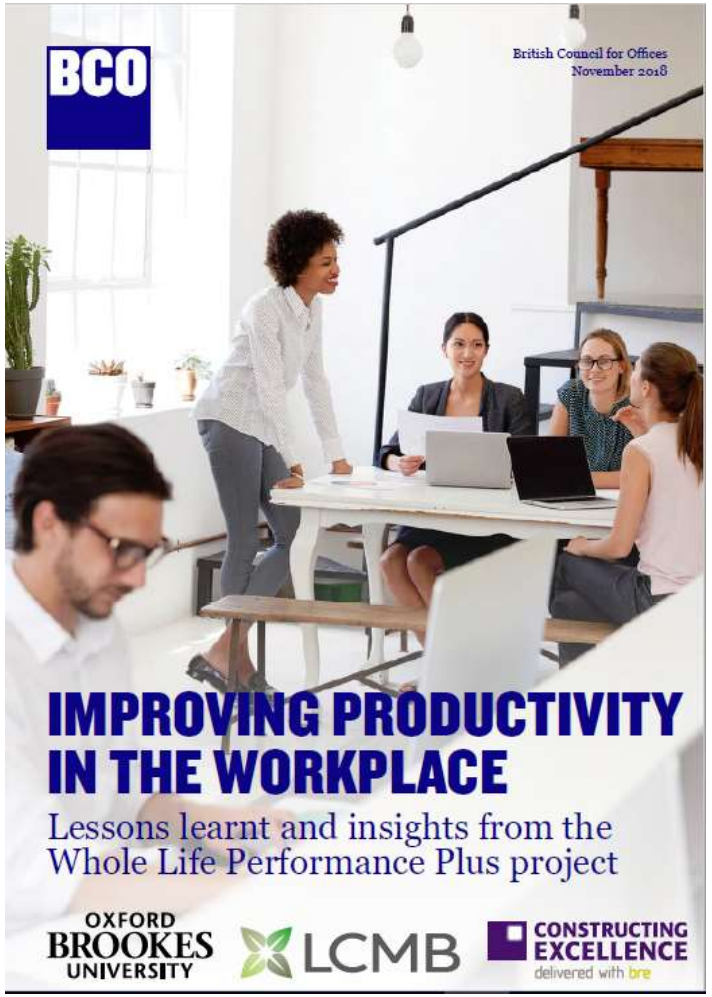
2017 - Performance in Use – Measuring Productivity



One Carter Lane - Europe 1st WELL Certified project


Measuring and predicting concentrations
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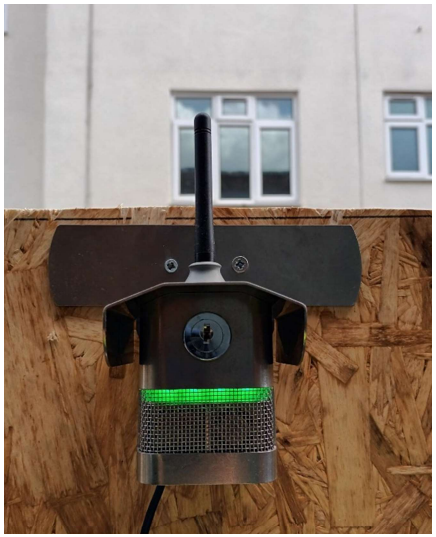
Monitoring Air Quality – Ambient

- **Placement**
- **Monitoring period**
- **Parameters**
- **Monitoring Equipment**
- **Interpreting results**



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Indoor Air Quality Monitoring

Monitoring- Cundall Capabilities

AWAIR

Sampling Tubes

Earthsense Zephyr

Parameter	AWAIR	Zephyr	Sampling Tubes
CO_2	✓	✓	✓
NO_2	x	✓	✓
PM_{10}	x	✓	x
$PM_{2.5}$	✓	✓	x
O_3	x	✓	✓
TVOC	✓	✓	✓
Formaldehyde	x	x	✓
Humidity	✓	✓	x
Temperature	✓	✓	X

Zephyrs can also monitor PM_1, SO_2 and H_2S

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Cundall is committed to providing people with the knowledge, skills and enthusiasm to make a difference: in our homes, our offices, our projects, our industry and our community. We are the world's first consultancy to be formally endorsed as a **One Planet Company** by sustainability charity BioRegional.

All

Sensor
5th Floor Printer
6Pax- Meeting Room
Aviation
C&S
CAD
Cundall hk Office
Cundall Room
Cundall Singapore Office
Cundall Singapore Reception
Cundall_test1
Dubai_Open Plan
Dubai_Phone Booth
Edin_Anna's desk
IEQube-BNE-02
ieQube-MEL-05
IEQube-MEL-06
IEQube-PER-01
IEQube-PER-02
IEQube-SYD-03
IEQube-SYD-04
IEQube-SYD-05
IEQube-SYD-06
IEQube-SYD-08
Lifestyle
Light4
Madrid Office
Meeting Room 1
My Desk
Office east
Office north (Finance)
Office north-east
Office south
Office south-east
Phone booth _2
Reception
Reception _ Breakout
Red Desks
Seating Space (Middle)
Sustainability
VB
Workplace
Wrocław

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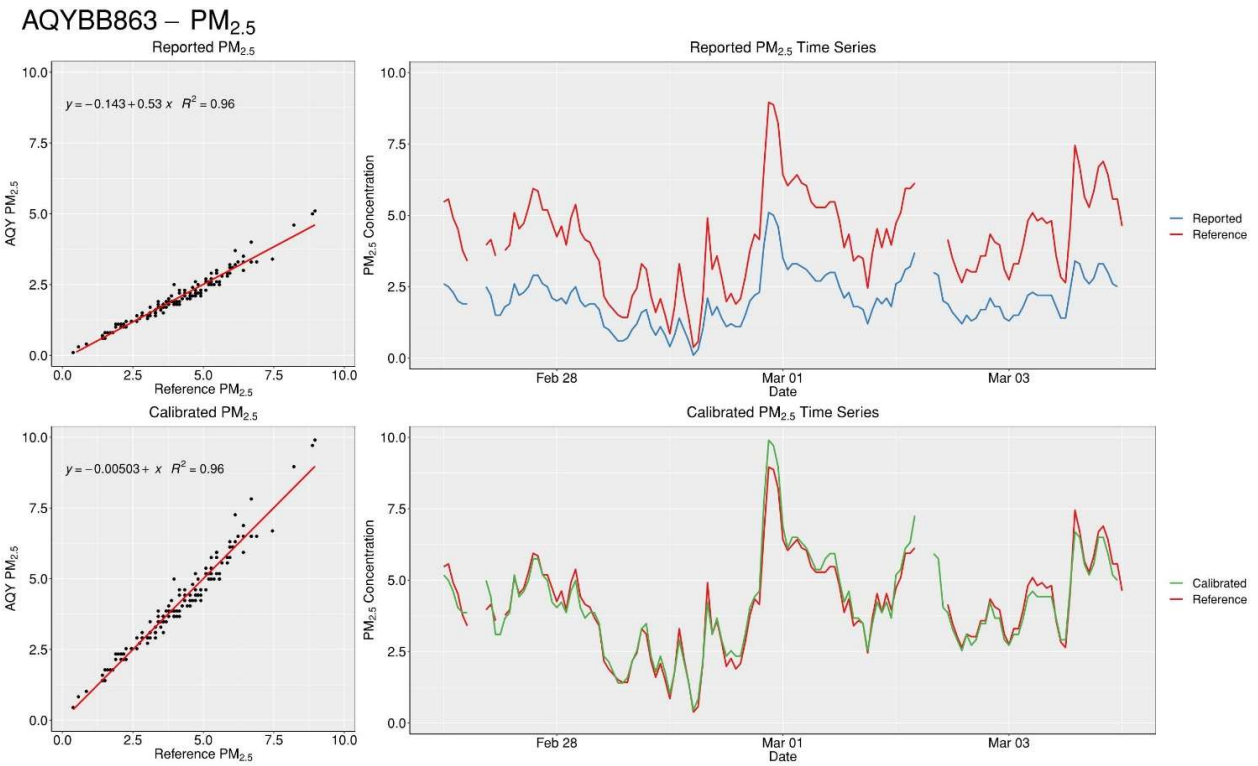
Indoor Air Quality Monitoring

Recent Projects

Colocation of $PM_{2.5}$ monitor with Birmingham's ambient monitoring network and Awair sensors



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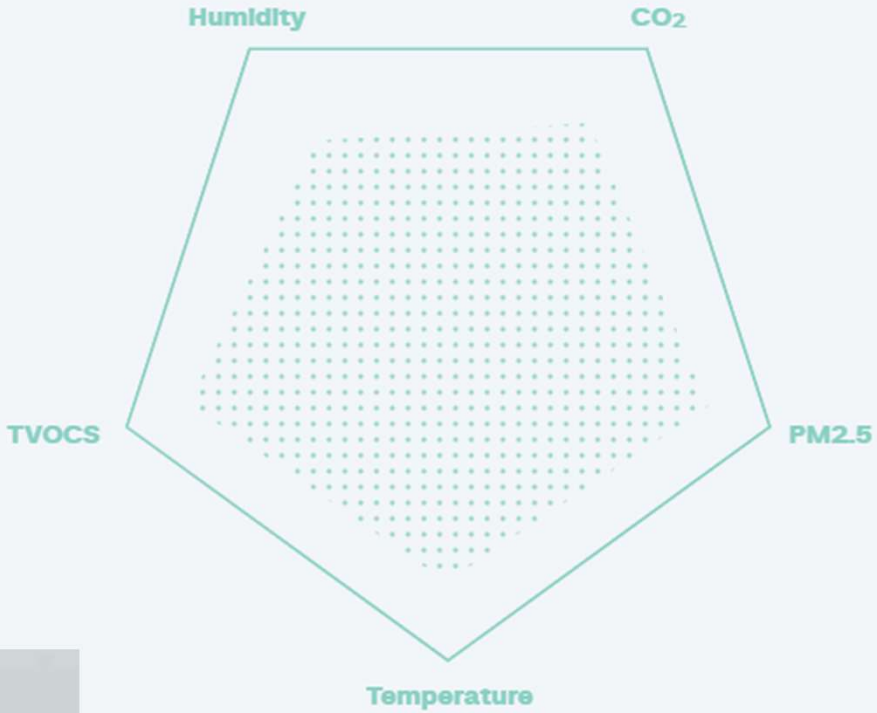
AirRated

Tiers	AirScore	AirScore D&O
Platinum	9.4+	8.5+
Gold	8.6 – 9.3	7.5 – 8.4
Silver	7.8 – 8.5	6.5 – 7.4
Certified	6.6 – 7.7	5.0 – 6.4



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RESET

Performance Targets for the Commercial Interior Project Typology

PM2.5 Particulate Matter	TVOC Total Volatile Organic Compounds	CO_2 Carbon Dioxide	Temp Temperature	RH Relative Humidity
Acceptable < 35 µg/m³	**Acceptable** < 500 µg/m³	**Acceptable** < 1000 ppm	**Monitored**	**Monitored**
High Performance < 12 µg/m³	**High Performance** < 400 µg/m³	**High Performance** < 600 ppm	Although there are no requirements for temperature and humidity under **RESET** Air, both must be monitored given their impact on sensor readings for PM2.5 and TVOC.	

Performance Targets for the Core & Shell Project Typology

PM2.5 Particulate Matter	TVOC Total Volatile Organic Compounds	CO_2 Carbon Dioxide	Temp Temperature	RH Relative Humidity
Required ≤ 12 µg/m³ or ≥ 75% Reduction*	**Required** ≤ 400 µg/m³	**Required** ≤ 800 ppm or ≤ 350 ppm over outdoor levels to a maximum of 900 ppm	**Monitored**	**Monitored**
			Although there are no requirements for temperature and humidity under **RESET** Air, both must be monitored given their impact on sensor readings for PM2.5 and TVOC.	

*Note that if TVOC is in ppb, the equivalent to 500 ug/m3 and 400 ug/m3 is 220 and 176 ppb respectively. Learn more in the FAQ.

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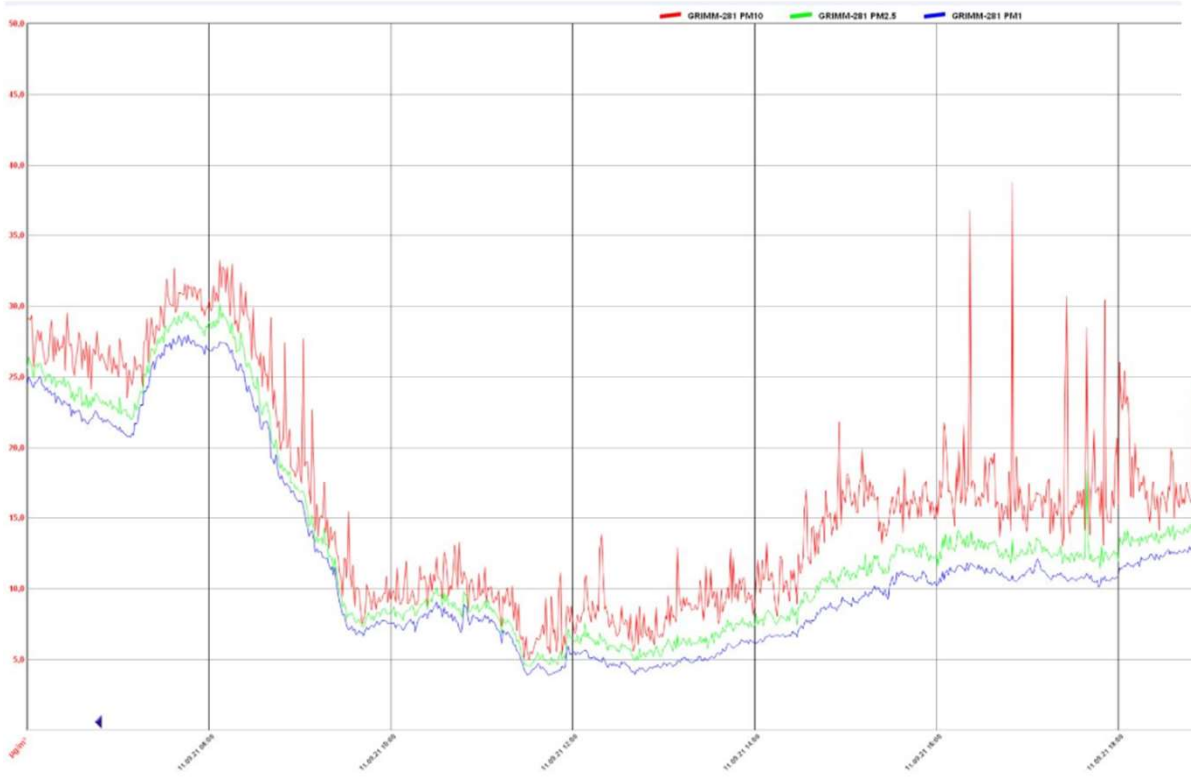
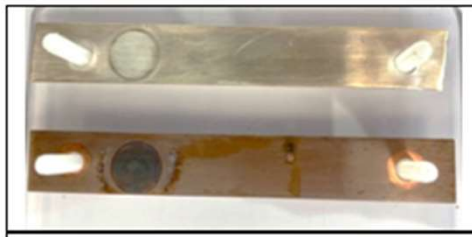
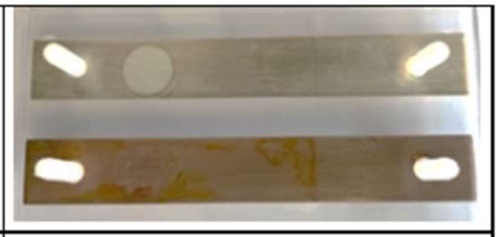
Atmospheric corrosivity

Panel No.	*202100934-9*	*202100934-10*	*202100934-11*
Site	***Nr 2***	***Nr 1***	***Nr 3***
Copper Corrosion	7460	4520	4716
Silver Corrosion	231	157	239
Classification	**GX**	**GX**	**GX**





202100934-9



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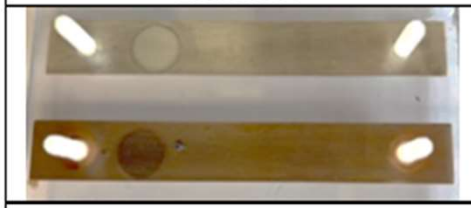

202100934-11

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Early building design input
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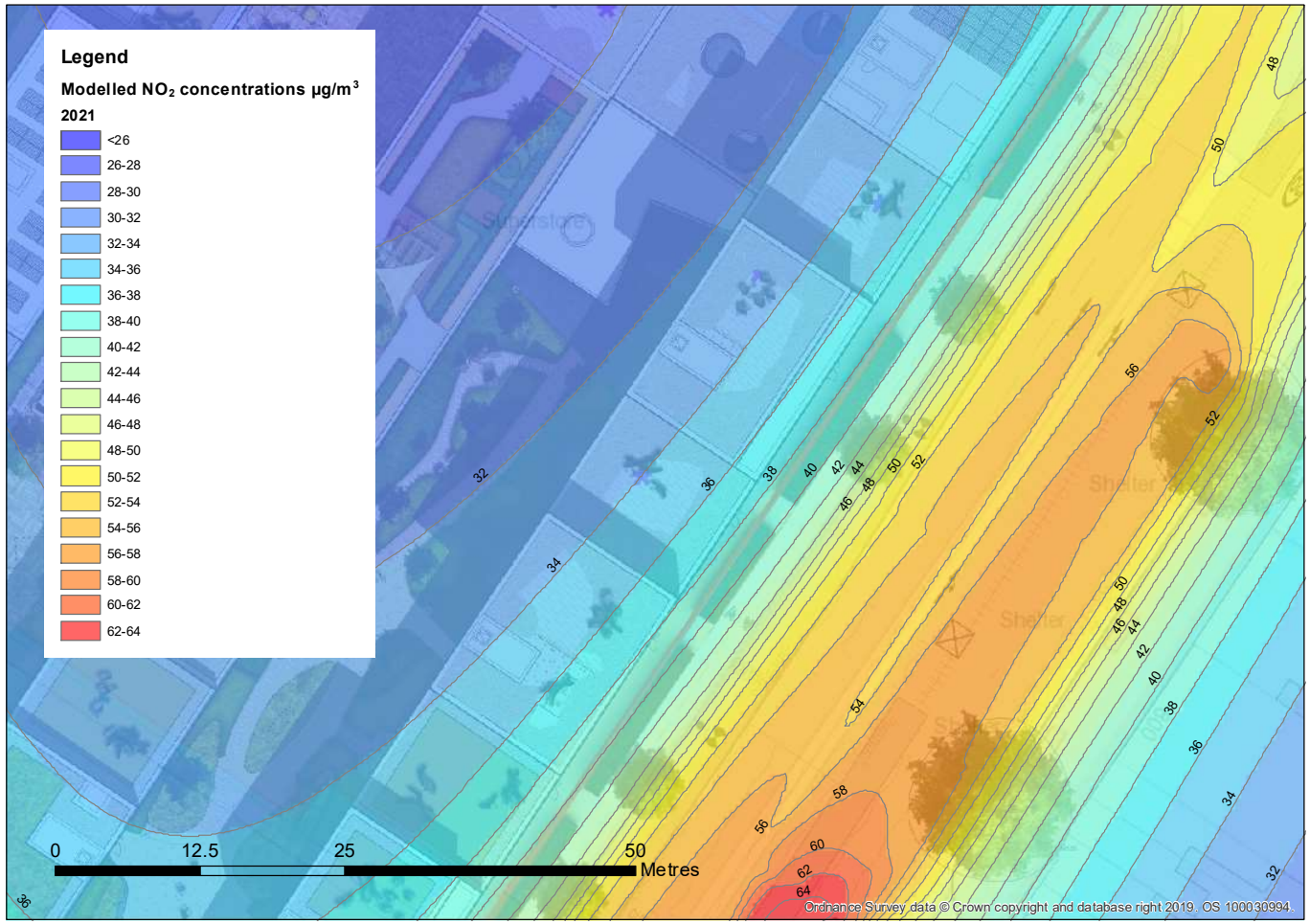
Modelling to inform ventilation strategy



Mitigation Strategies:

Selly Oak Case Study

- Building / Façade Position
- Location of habitable rooms
- Natural / mechanical ventilation

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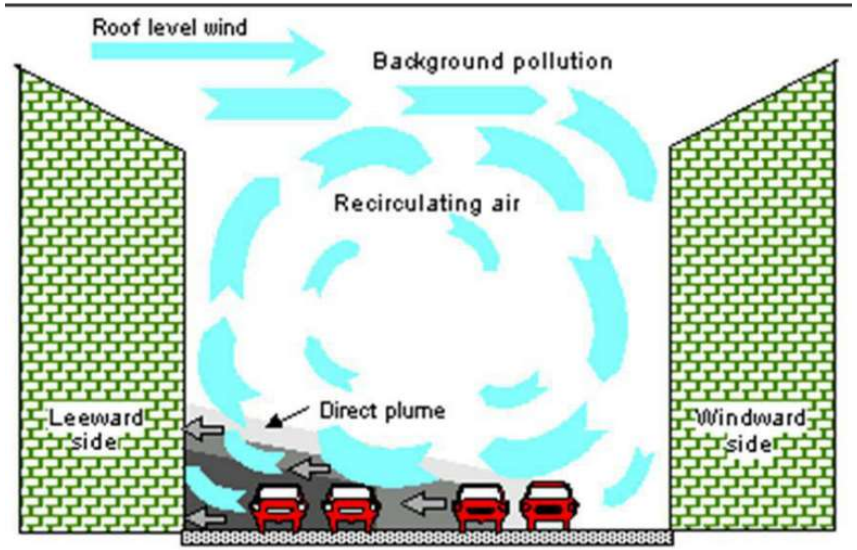
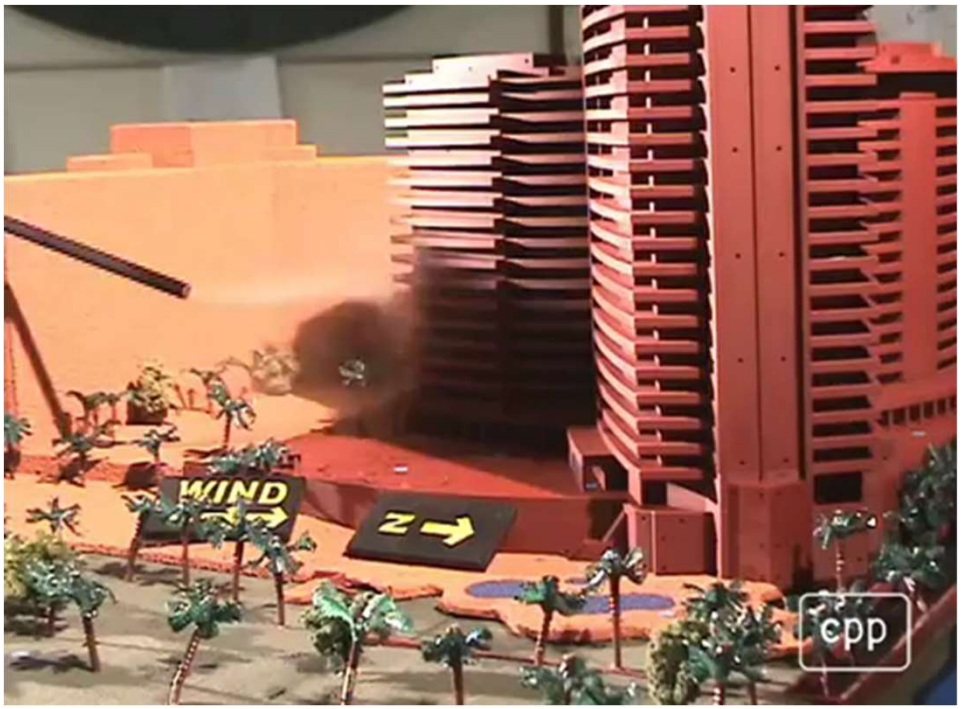
Building Geometry



Source: https://www.researchgate.net/figure/Urban-street-canyon-model-20_fig3_281746892

Source;
https://en.wikipedia.org/wiki/Urban_canyon#/media/File:42nd_Street_in_Tudor_City.jpg



Urban building density -

- Building ‘downwash’
- ‘Street Canyon’ effects

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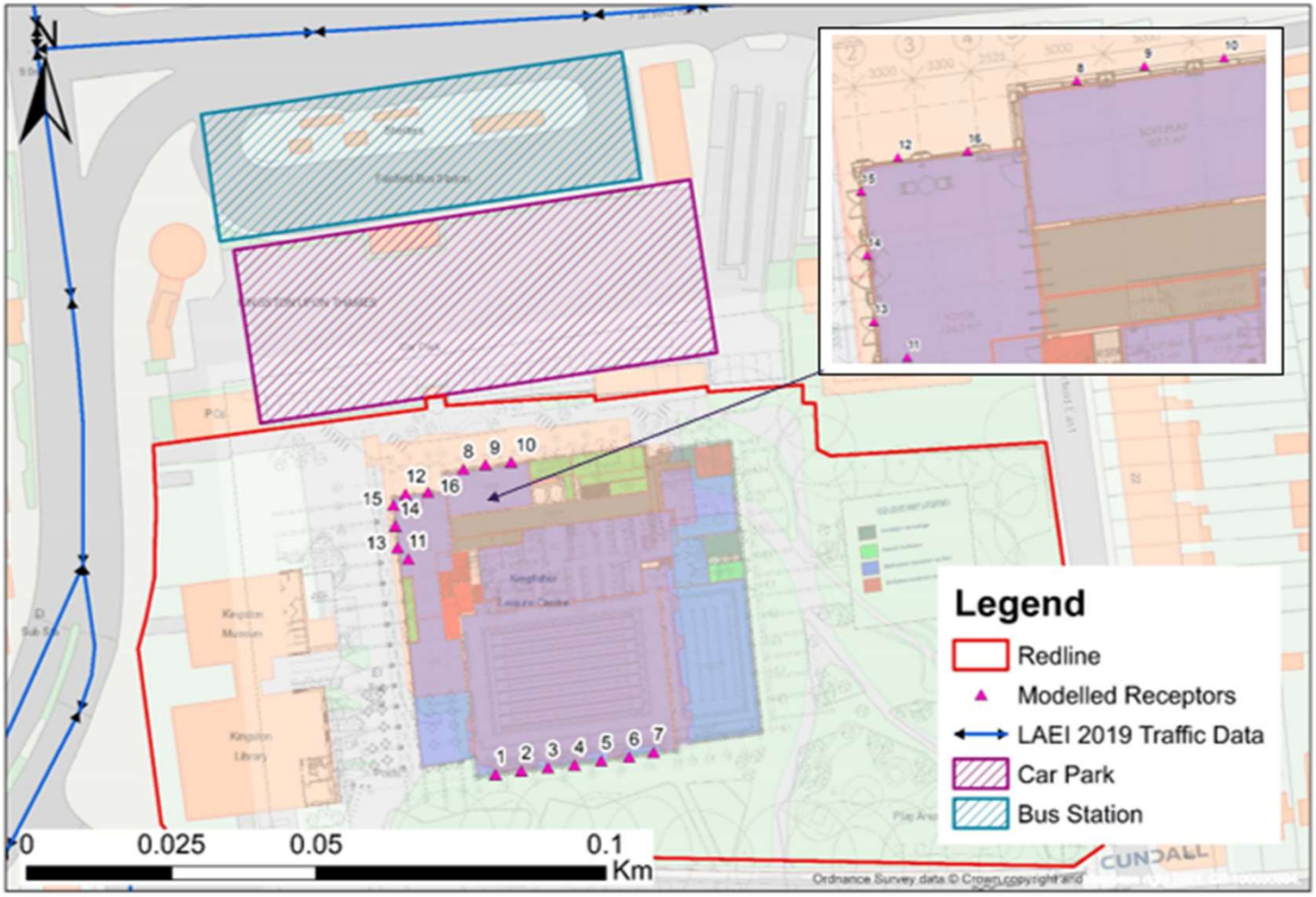
Considerations for placement of air intakes



- Dispersion modelling to predict impact at on-site air intakes, as well as on-site and off-site areas of receptor sensitivity

In accordance with BREEAM Hea02:

- For air conditioned and mixed-mode buildings, that air intakes and exhausts are to be located **at least 10m apart to minimise recirculation** and intakes are to be located over **20m from external sources** of pollution.
- For naturally ventilated areas: openable windows/ventilators will be **over 10m horizontal distance from sources of external pollution**, including any building related air exhausts.

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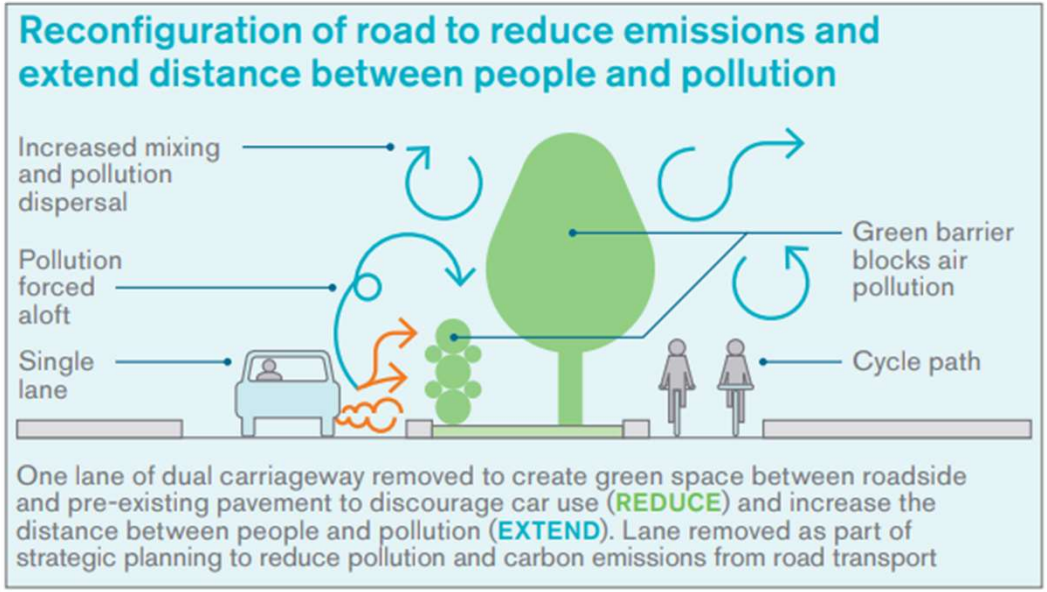
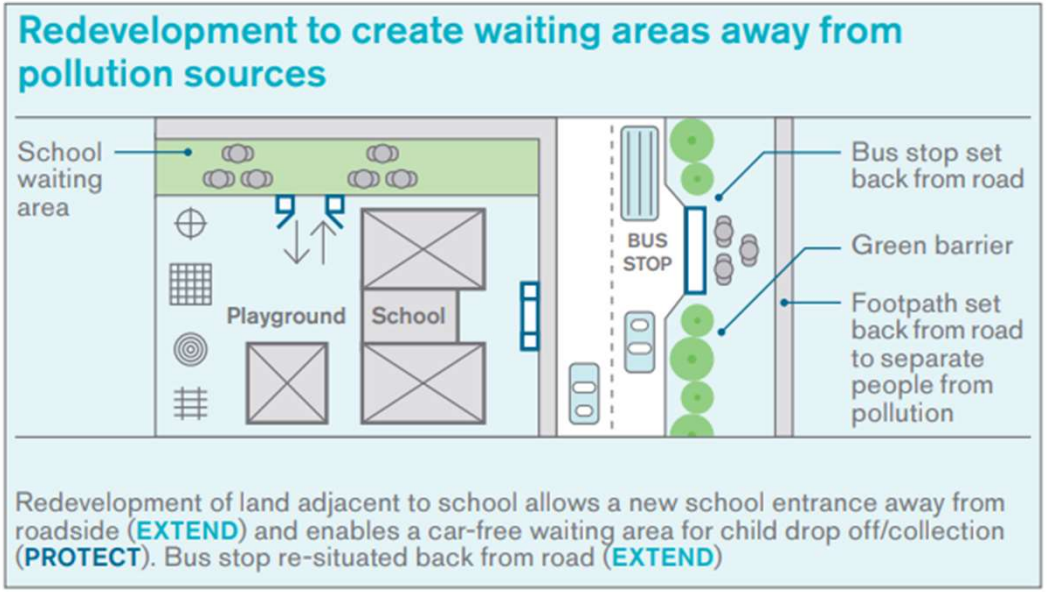
Masterplanning and landscape design

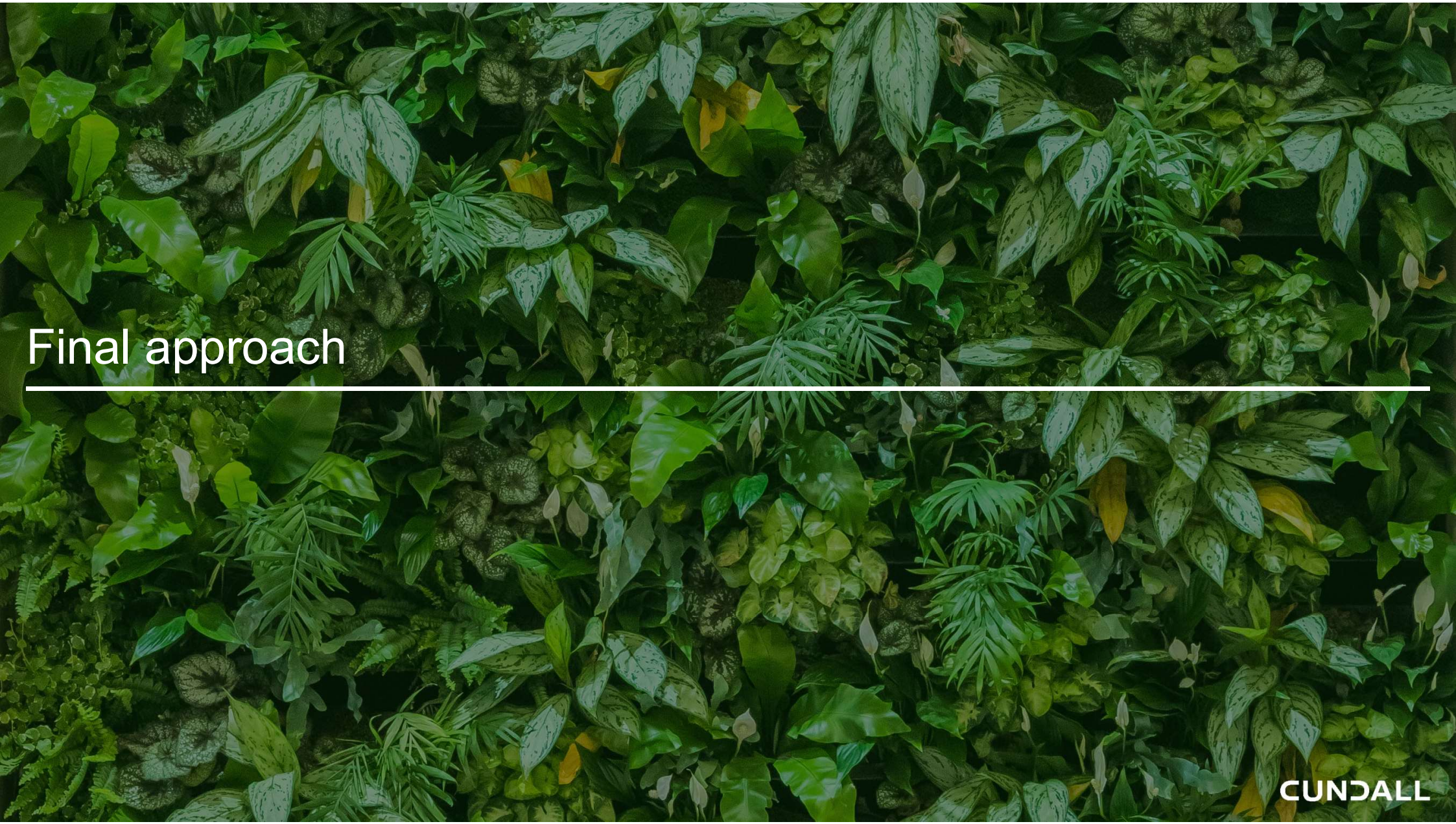
Air Quality design mitigation:

- **Reduce** emissions –
  - Transport- facilitate active transports, provide links to public transport, electric car charging points
  - Energy design – discourage combustion, including wood.
- **Extend** – increase distance between source and receptors (including air intakes for mechanical ventilation)
  - Actual distance or effective distance – barriers force polluted air to take a longer path or via a heterogeneous surface that creates eddies and encourages mixing
- **Protect** – separate vulnerable people from pollution (outside hospitals, schools, at bus stops)





Source: University of Birmingham, http://epapers.bham.ac.uk/3493/1/WM-Air_Design_Charter.pdf


Final approach
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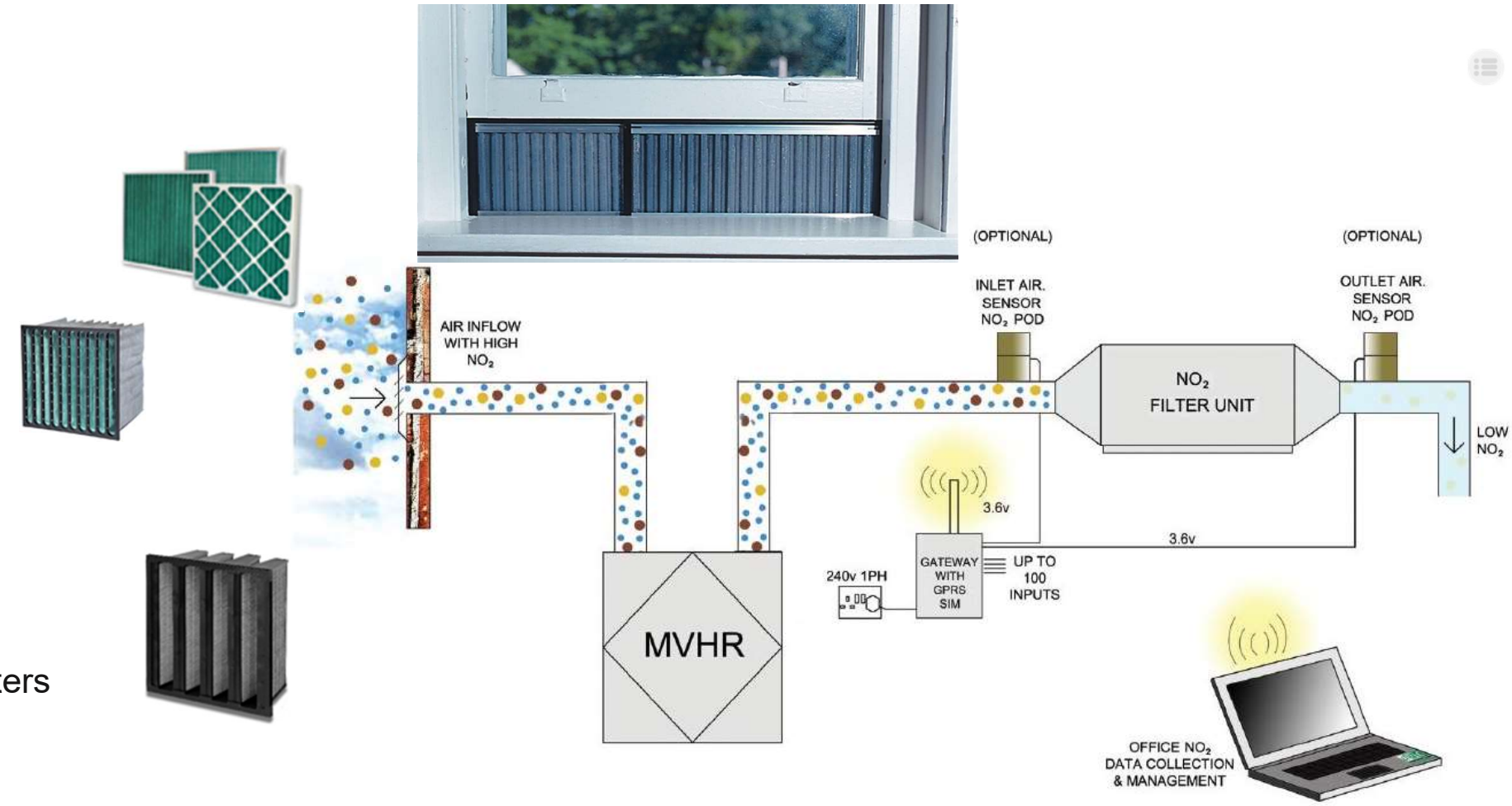
Filtration

- Panel filters
- Bag filters
- HEPA
- Carbon gas filters



As well as air quality conditions, consideration needs to b

- installation feasibility and appropriateness;
- lifecycle and maintenance costs; and
- correct installation.

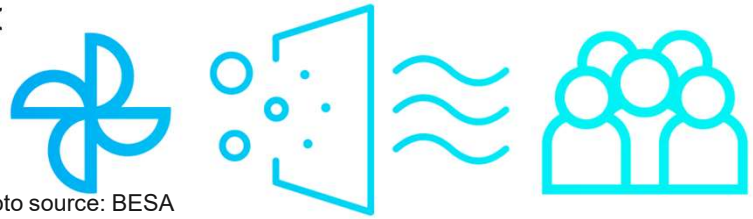


Photo source: BESA

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Healthy Materials

MATERIALS

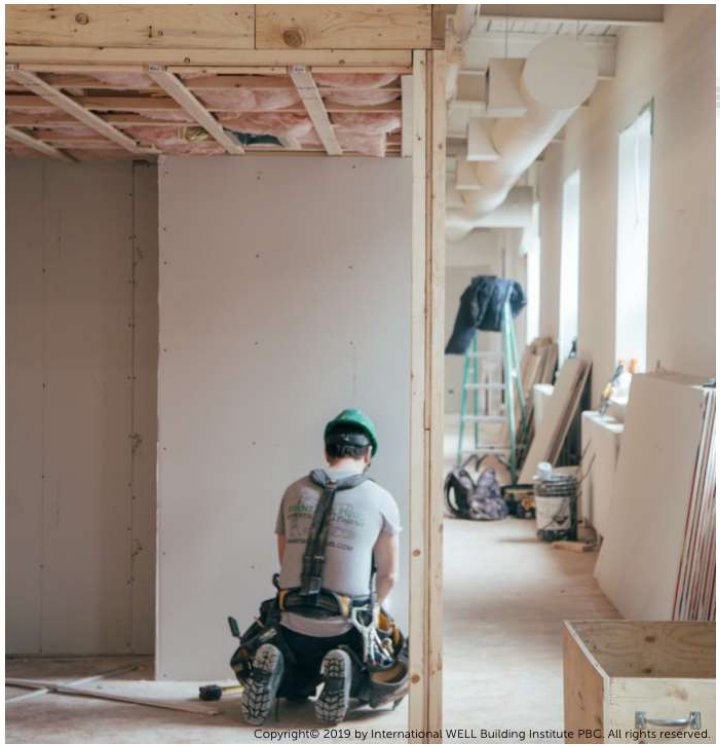
WELL promotes strategies to reduce or minimise sources of indoor air pollution.

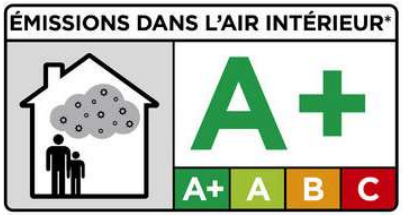
- Air quality testing
- Materials selection
- Ventilation and filtration
- Moisture control
- Maintenance and operations
- Constructions processes

THE ISSUE

An estimated 95% of chemicals largely used in construction lack sufficient data on health impacts.[1]

1. Pacheco-Torgal F, Jalali S, Fucic A. Toxicity of Building Materials. Sawston, Cambridge: Woodhead Publishing Limited; 2012.





- Advise on selection of materials
- Operational use and impact of certain practices and products on indoor air quality.

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Evolving consultancy advice

- Support research project WM-Air Uni of Birmingham
- Keen to keep in the loop with updates in research, innovation

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Any questions?

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